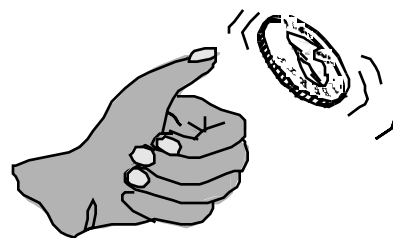


Warm-Up 4

Risk Concepts



Duration	1 class period
Grade Level	7-10
Key Terms/ Concepts	Environmental Risk Risk Probability
Suggested Subjects	Biology Chemistry Creative Writing English Life Science Physical Science Mathematics

Purpose

In this exercise, students explore the meaning of risk in terms of a simple exercise in probability. They explore the idea that not all risks have the same consequences and are not likely to occur at the same rate. The exercise helps students to evaluate the impact of risk on the basis of probabilities, benefits, and their perceptions.

Background

Nothing in life is a "sure thing." While it is unlikely that it will snow in Texas in April, it is possible. In the same way, it is unlikely that it will be 80 degrees in Massachusetts in December, but it is possible. Saying something is "unlikely" or that it "probably will happen" is an indication of the **probability** that this particular thing will occur. Every day you weigh probabilities even without realizing it.

For example, when you take a test, you think about the chances of getting an "A." How likely you think it is that you'll get an "A" depends on how well you studied and how hard you think the test will be. Or, if you want to be picked for a team, the chances that you'll make it depends on how many other people want to play and how good you are in comparison to everyone else.

When it comes to the environment, the chance of something dangerous happening is called **risk**. Each type of hazardous substance, hazardous waste, or dangerous situation involves a different amount of risk. The risk is made up of two parts: (1) the chance that people will be exposed to the substance, and (2) the chance that exposure will injure or harm them. **Environmental risk** measures the probability that the environment will be damaged by a particular hazardous situation. Decisions on cleaning up a Superfund site are based on the risks the site poses to people and the environment.

There are generally many factors involved in determining the risks surrounding a particular hazardous situation. These factors include the potential for damage each particular substance can cause, the chances that the substance is going to spread from the original site through water, wind, or some other means, and the chance that people will come in contact with the substance.



In this Warm-up, students perform a simple exercise in probability to gain a beginning understanding of how chance operates. For additional information on probability, and risk, and environmental risk assessment, see the Suggested Reading list found at the end of the Haz-Ed materials. Other Haz-Ed materials that are related to this topic include *Activity 7: Identifying Risks at a Superfund Site* and *Activity 9: Making Decisions about Hazardous Waste Cleanup*.

Preparation

1. Gather the following materials:
 - Several coins
 - Several sheets of paper
 - Several pencils
 - Copies for each student of the Student Worksheet, *Risks and Benefits*.

Procedure

1. Explain to students that the class is going to conduct an exercise in probability by tossing a coin. Explain that, for one brief moment, when a coin is tossed into the air, it assumes a state of unpredictability. We know that it will either be heads or tails, but we cannot know which one while the coin is in the air. Even so, in repeated trials under similar conditions, we do know that heads will come up half the time and tails the other half. This illustrates the theory of probability—how likely it is that a particular result will occur in a given situation.
2. Organize the class into groups of about 2 or 3 students each. Give each group a penny, a piece of paper, and a pencil. If necessary, demonstrate how to toss a coin to determine heads or tails.
3. Instruct each group to flip the coin 50 times, recording the results of each toss. Have the students record the total number of heads and total number of tails that occurred after:
 - 5 coin flips
 - 10 coin flips
 - 25 coin flips
 - 50 coin flips.

Record each group's results on the chalkboard.





4. Explain that few events are as predictable as a coin toss. No matter how many times a coin comes up heads, there is only a 50-50 chance that the next toss will be tails. While the ratio of heads to tails may vary with only a few repetitions, the ratio stabilizes at or near one-half after many repetitions. (For example, theoretically it would take a million people tossing coins 10 times a minute 40 hours a week for 9 centuries for a coin to fall on heads 50 consecutive times.)
5. Have the class compare the results of the coin toss exercise for each group. Did the ratio of heads to tails vary after 5 tosses? After 10 tosses? Was the final ratio about one-half? If not, why?
6. Explain that although the coin toss demonstrates the fundamental principle of probability, determining the risks of injury, disease, or death from a particular hazard is far more complex. This is true mainly because these risks are dependent on the occurrence of other factors, and the interaction of multiple factors, such as contact (or exposure) to the hazard that causes the effect.
7. Distribute a copy of the Student Worksheet, *Risks and Benefits*, to each student and review the instructions for both parts. Give students about 10 minutes to complete the worksheet (individually or in small groups). Have students discuss their answers to the questions.

Extensions (Optional)

- Assign students to go to the library and look up details to support the answers they gave in Part B of the worksheet (for example, what gasoline is made of and why it is harmful, the number of automobile or airplane accidents that occur each year, or where PCBs come from).
- Have the students write a short story about how one of the risks listed in the worksheet was harmful to people or the environment. This may require students to conduct some research. The resources in the Suggested Reading list are helpful. Allow the students to base their story on a true event if they wish. Select the best stories, and ask the students who wrote them to summarize them for the class. Discuss the stories in terms of the students' personal willingness to accept voluntary and involuntary risks.



Risks and Benefits

Part A

For each situation listed below, describe a potential danger (something that could happen that would cause concern for public health). List at least two ways people or the environment could be injured and, if possible, at least one benefit that people or the environment could gain from it.

- Transportation of a hazardous substance on highways near urban areas (see example on second page)
- An old municipal and industrial dump that does not meet current design and safety standards
- A large housing area built on an unknown hazardous waste site contaminated with polychlorinated biphenyls (PCBs)
- Storage of gasoline in underground tanks at local gas stations
- Travel by automobile
- Travel by airplane
- Cigarette smoke
- Pesticides
- A tornado



EXAMPLE: Transportation of a hazardous substance like mercury on highways in urban areas

What Could Happen: A traffic accident causes the container to rupture and release mercury into a lake or stream.

Injury: Mercury builds up (bioaccumulates) in the fish, which people and wildlife eat, and threatens the public water supply serving many people downstream. People and wildlife may become ill, some may die, and offspring suffer severe birth defects.

Benefit: Mercury is used in manufacturing many important products, including paint and paper and in processing leather. It is a key element in dental fillings, thermometers, and some fungicides and insecticides.

Part B

Now, answer the following questions:

1. How would you rank the situations in Part A in terms of how risky they are and how likely injuries are to happen?
2. How would you rank the risks in terms of the number of people affected and the severity of the possible harm? (That is, which situations present the deadliest and most widespread risk?)
3. Which of the risks are you willing to accept (voluntarily), and which do you have to accept (involuntarily)? (For example, you can choose not to smoke cigarettes but you may not be able to prevent the transportation of hazardous substances along a highway near where you live.)